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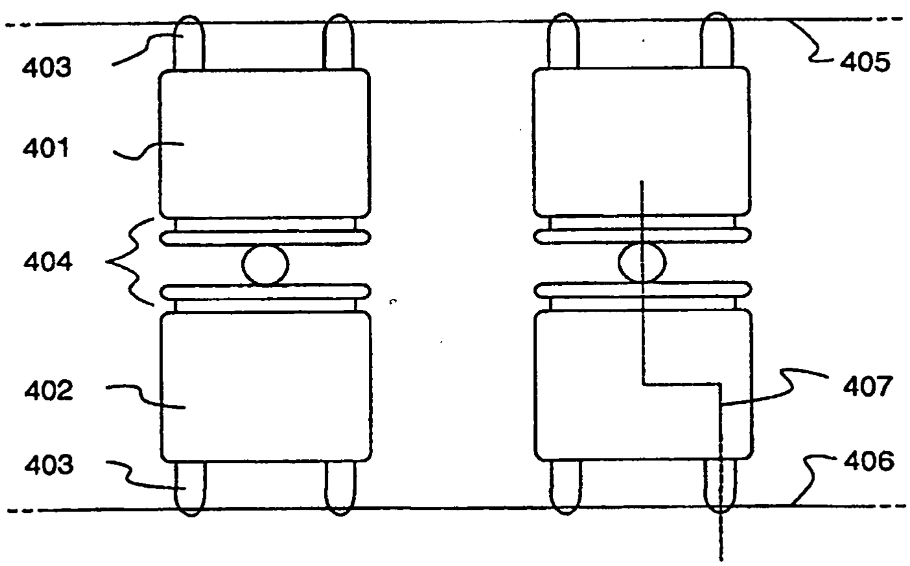
(57) Abstract



Workpieces are treated in a manufacturing process, where separate workpieces are formed by solidification of liquid or viscous material in a mould (302). The successive workpieces form a band, in which a reinforcement (301) of a material other than the material to be solidified is interposed between the workpieces to enhance the mechanical strength of the band. A reinforcement (405, 406, 1401, 1402) comprising two parallel elongated means are interposed between successice workpieces with the parallel elongated means passing through the mould (302). The liquid or viscous material to be solidified is introduced into the mould over a given point (501, 1405, 1415) located between said parallel elongated means. An attachment (403, 606, 702, 1406) is formed between each workpiece and said parallel elongated means in the parts of the mould through which said parallel elongated means pass.

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Method and apparatus for handling workpieces in a manufacturing process

The invention relates to a method and an apparatus for facilitating the handling of serially produced workpieces in a manufacturing process where the workpieces are formed as a liquid or viscous material is solidified. This patent application deals with injection moulding as an exemplifying manufacturing process. During the process, a workpiece generally implies the piece of material that will form a given product at the end of the process.

FI Patent Application 963,873 discloses a manufacturing process and apparatus, in which semi-finished workpieces are connected in succession and perhaps also in parallel by connecting bridges. Figure 1 shows how the workpieces 1 produced in a given production step form an elongated continuous band, which is wound up in a roll 4. In the example illustrated in the figure, the raw material used is conceivably plastic to be injection moulded, and the products 1 to be produced are small plastic objects. For consecutive pieces not to be detached, the jaws of the press in figure 3 have been designed such that the "rear end" of each workpiece (the right-hand end in the figure) will comprise a small plastic tongue, which is superfluous in terms of the shape intended for the product. When the following workpiece is injection moulded, its "front end" (left-hand end in the figure) will also comprise a small plastic tongue, which is superfluous in terms of the shape intended for the product and is fused with the tongue at the rear end of the preceding workpiece. A bridge 2 of the same material as the actual workpieces will be formed between successive workpieces.

Figure 2 illustrates the surface treatment included in the same manufacturing process. The band of workpieces is brought to surface treatment in a roll 6. The workpieces are introduced as a band in a dip paint basin 7 and from there to surface spray painting 8 and to a drying machine 9. Other exemplifying surface treatment steps illustrated by figure 3 include printing 10, gluing of a sticker or a label 11 and providing an identifying pattern by means of laser 12. Two options are given as the last step in the figure. In the first option, a laser cutter 13 separates the workpieces 15 from the band, and they must then be handled in the way individual pieces usually are. In the second option, the finished workpieces are additionally wound up in a roll 14 or folded in a pile, thus allowing them to be easily transported and placed in the assembly step of a more complex product.

However, the prior art process described above has proved awkward in practice, because the bridges made of injection-moulded material connecting consecutive workpieces do not withstand all process steps properly. What is more, they hamper the handling of the band of workpieces in some process steps.

The typical feature of manufacturing processes based on the solidification of a liquid or viscous raw material is that the material is guided to the desired locations of a mould through one or more "pouring channels". In the solidification step, the pouring channels will still contain material, this material portion forming a "sprue". The actual workpiece and the sprue are connected by a thin bridge of material at the point where the pouring channel was in contact with the mould of the actual workpiece. The sprue is generally utilised in the further processing of the workpiece, because a surface treatment intended to cover the entire surface of the workpiece, for instance, is easy to perform by holding the sprue. US patent specification 5, 478,051 discloses a process in which, after pressing, the plastic parts to be injection moulded form a band in which a separate reinforcing wire passes through the sprues and connects consecutive parts. The publication describes both embodiments in which the wire consists of the same material as the pieces to be injection moulded, and embodiments in which the wire is a metal wire, for instance. Similar solutions are dislcosed in US patent specifications 4,008,302 and 3,192,298.

The object of the present invention is to propose an improved process and apparatus for manufacturing workpieces by forming a band of consecutive and/or parallel workpieces which is advantageous in terms of further processing.

The objects of the invention are achieved by using a support wire or film which adheres to the solidified material during or immediately after the solidification step, and by an appropriate choice of the position of the support wire or film and of the flow directions of the material to be solidified.

The invention relates to a process for handling a workpiece in a manufacturing process comprising

- forming separate workpieces by solidifying liquid or viscous material in a mould
- forming a band of successive workpieces
- interposing a reinforcement made of some other material than that to be solidified between successive workpieces in order to enhance the mechanical strength of the band.

The process of the invention is characterised by

- interposing between successive workpieces a reinforcement comprising two parallel elongated means, with these parallel elongated means passing through the mould
- introducing the liquid or viscous material to be solidified into the mould over a given point between said parallel elongated means
- forming an attachment between each workpiece and said parallel elongated means in the mould parts through which said parallel elongated means pass.

The invention also relates to an apparatus comprising

- a mould for forming separate workpieces by solidification of a liquid or viscous material
- means for interposing a reinforcement of a material other than the material to be solidified between the successive workpieces so as to form a band of successive workpieces.

The apparatus of the invention is characterised in comprising

- means for placing two parallel elongated means to pass through the mould
- means for introducing liquid or viscous material into the mould over a given point between said parallel elongated means
- means in the parts of said mould through which said parallel elongated means pass for forming an attachment between each workpiece and said parallel elongated means.

The workpiece mould may comprise projections in which material is also solidified during the injection moulding, thus forming parts that are not intended to remain in the finished product. Such projections comprise i.a. air pockets, through which air or any other gaseous substance escapes from the mould to make way for the liquid or viscous raw material. "Ejection pins" are preferably formed in connection with the sprue or other projections to allow the solidified workpiece to be detached from the mould.

In accordance with the invention, a reinforcing wire or band is used between such parts of successive workpieces which are not intended to remain in the finished product. It has proved especially advantageous to guide the reinforcing wire through a projection formed in the workpiece under the effect of an air pocket in the mould. It is also advantageous that the projection comprises an ejection pin at the

reinforcing wire, because this results in an increase in the material thickness and reinforced attachment of the workpiece to the reinforcing wire or band. It is especially advantageous to provide an ejection pin or point on a projection which will not remain in the finished product when a high-quality surface is required for the product say, for optical reasons.

The efficiency of the manufacturing process can be appreciably enhanced by using two reinforcing wires, which are placed at the outermost edges of a band of successive workpieces, and by interposing the point of raw material supply between the reinforcing wires. This allows an adequate material flow from one or more supply points in order to form even several workpieces at the same time.

The invention is described more in detail below with reference to preferred embodiments given by way of example and to the accompanying drawings, in which

figure 1 shows a conventional manufacturing process,
figure 2 shows a conventional finishing treatment,
figure 3 shows a manufacturing process of a preferred embodiment of the invention,
figure 4 shows a workpiece manufactured in the process of figure 3,
figure 5 shows a detail of the workpiece of figure 4,
figure 6 shows an optional workpiece manufactured in the process of figure 3,
figure 7 shows a preferred workpiece design,
figure 8 shows a second detail of the workpiece of figure 4,
figure 9 shows ways of placing the ejection pins,
figure 10 shows a way of positioning the workpiece in the process,
figure 11 shows a lateral view of the positioning of figure 10,
figure 12 shows a preferred workpiece shape,
figure 13 shows a cross-section of the pouring channel in the workpiece of figure 12,
figure 14 shows the application of the invention to two-step injection moulding and
figure 15 shows a cross-section of the workpieces of figure 14.

The description of prior art above referred to figures 1 and 2, and thus the following description of the invention and its preferred embodiments will refer mainly to figures 3-15. The same reference numerals are used for mutually corresponding parts in the figures.

Figure 3 shows a manufacturing process of a preferred embodiment of the invention. In order to form a band of pieces, one or more wires supplied from a roll 301 are used. Using a method based on the solidification of a liquid or viscous raw material, workpieces are formed in the mould 302 with the one or more wires passing through a given part of each workpiece. At 303 the workpieces are lacquered by spraying and the solvents in the lacquer are evaporated in evaporator 304. The lacquer is subjected to ultraviolet curing at 305, which may be followed by other treatment steps, such as one or more impressions 306 and 307, curing of the pigment used in the printing by any radiation process 308, and separation of the pieces from the one or more wires acting as a conveyor at 309. The conveyor wire or wires are preferably wound up as a roll 310 and the finished pieces 311 are removed from the process. To support and move the band of pieces in the process, various band conveyors can be used, of which figure 3 especially illustrates a conveyor equipped with a disposable band 312, which is intended to protect the actual conveyor from the lacquer used in the spray lacquering process.

Figures 4 and 5 show a workpiece shape which can be manufactured in step 302 of figure 3. The workpiece consists of two service members 401 and 402 having a rectangular shape with rounded corners, two conveyor tongues 403 connected to each service member, and a sprue 404. The conveyor tongues are formed at the location of air pockets in the mould. The wires for forming a band of consecutive workpieces are marked with reference numerals 405 and 406. Figure 5 is a cross-section along the broken line 407, showing an exemplifying shape of the sprue. The sprue in figure 5 consists of a primary pouring channel 501, flowing channels 502 and secondary pouring channels 503. Figure 5 also shows an exemplifying conveyor tongue 403 in cross-section. The conveyor tongue and the sprue have the common feature of both being removed from the service member before this is definitely finished. In figure 5, the wire 406 passes through the conveyor tongue 403, however, it could also be attached to the surface of the conveyor tongue.

The workpiece shape shown in figures 4 and 5 yields many advantages. The service members 401 and 402 are assumed to be windows made of transparent plastic, which are used to protect the display of a small-sized electronic device, such as a mobile phone. High requirements are posed on the optical quality of the window: it should preferably be transparent over its entire area, and the service member must not be touched during the process, because the manufacturing process must not leave any kind of scratches or harmful marks on its surface. The window must not either cause optical distortions or undesired polarisation effects. When the material

to be injection moulded is introduced into each workpiece through the flowing channel 502 and the secondary pouring channel 503, the molten material flows as a large front into the service member part of the mould, thus preventing optical distortion and polarisation effects from arising. To remove air and any other gaseous substances from the passage of the molten material, the mould must comprise air pockets, which are preferably placed as far as possible from the point of material input: as a result of this, the conveyor tongues 403 will be automatically formed. In addition, the portion of the injection-moulded material that has penetrated into the mould first and is susceptible to poor optic properties due to the temperature difference between the material and the mould is removed from the service member part through these air pockets. The symmetrical supply of material to be injection moulded between two support wires 405 and 406 allows two service members to be manufactured simultaneously as an integrated part of a workpiece.

Figure 6 shows a variant of the embodiment of figures 4 and 5. The workpiece in figure 6 can be made in a process similar to that of the workpiece of figures 4 and 5, using similar support wires 405 and 406. Of course, the mould has to be different. The workpiece appearing in figure 6 comprises four mutually identical service members 601, 602, 603 and 604, and a sprue 605 in common for all of these. Each service member comprises two conveyor tongues 606, which are located on the opposite side of the service member relative to the sprue 605, and which arise owing to the air pockets in the mould and through which the support wires pass. The material is introduced into each service member part through the flowing channel 607 and the secondary pouring channel 608, the material flowing into each service member part as a large front, thus contributing to achieve high optical quality. In the light of figures 4, 5 and 6, it is obvious that also other kinds of different workpieces can be manufactured by the principle of the invention.

Figure 7 shows an exemplifying shape of the conveyor tongues and the sprue parts, which are useful in the further reprocessing of the workplace, especially during painting or lacquering. If the service member 701 is intended to be treated with paint, lacquer or any other substance apt to flow, the parts of the conveyor tongues 702 and the sprue 703 directly connected to this member advantageously have a shape such that, at the joint between the service member and the supplementary part, the supplementary part is oriented in the direction which will point downwards immediately after the surface treatment in the process. In this manner, the surplus of liquid surface treatment agent will flow off on the supplementary part, and any liquid droplets will arise at such a location of the workpiece which will not remain

in the final workpiece. Similar flowing and drop forming locations can be provided in any part of the workpiece.

The description above does not take any standpoint to how to provide for controlled attachment and detachment of the workpiece to and from the mould. To achieve a controllable process, the workpiece advantageously remains attached to the one and same mould part each time a given workpiece has been injection moulded and the mould is opened. The workpiece remains especially advantageously attached to the "background" of the mould, i.e. the part through which no material to be injection-moulded is introduced. In addition, the product must be removable under control from the part of the mould to which it adheres as the mould is opened.

Figure 8 shows a cross-section similar to that of figure 5, however, with the difference that the workpiece comprises ejection pins 801, 802 and 803, in addition to the parts described above. They are formed of the material to be injection moulded in the same process step as the other parts of the workpiece. Since the recesses matching the ejection pins 801, 802 and 803 are located precisely in the part of the mould through which no material to be injection moulded is introduced, the workpiece will remain attached to this particular part each time the mould is opened as a result of the friction between the workpiece and the mould. The detachment of the workpiece takes place under control, so that ejection bars are pushed through this particular mould part and hit the ends of the ejection pins, thus demoulding the workpiece.

The use of ejection pins in an injection-moulded body is known *per se*. However, in the process of the method, appropriate positioning of the ejection pins may achieve a special benefit. Figure 8 shows specifically that the ejection pin 801 is located in the conveyor tongue 403 substantially at the same point where the support wire 406 passes through the conveyor tongue. This results in relatively large material thickness at the support wire, which prevents the workpiece from being unintentionally removed from the support wire. In addition, since the ejection takes place at the support wire, the stresses exerted on the support wire and the conveyor tongues during the removal are minimised. Figure 9 illustrates a number of preferred locations of the ejection pin with black dots.

Ejection pins can be utilised also in the steps of the manufacturing process following the injection moulding. In many process steps, it is advantageous that the workpiece be very exactly positioned at a given location or that it can be transported along a very precisely determined path. Figure 10 is a cross-section of a conveyor

tongue, a part of the service member and a part of a support and/or actuating member included in a specific manufacturing apparatus. The cross-sectional plane is perpendicular to the support wire 406. The conveyor tongue 403 at the edge of the service member 401 is supported by the support and/or actuating member 1001 such that the ejection pin 801 hits the groove 1002 in the support and/or actuating member. In addition, the outer end of the conveyor tongue bears against the wall 1003 of the support and/or actuating member. The figure also shows a second conceivable location of the support wire 1004. The support and/or actuating member may be e.g. round, and then the situation shown in figure 11 will arise. Figure 11 shows part of a wheel 1001, about which the band of successive workpieces rotates. For the sake of clarity, figure 11 does not show the wall 1003, even if figure 11 shows the arrangement of figure 10 in other respects, viewed in the direction of the arrow 1005. The groove 1002 must be deep enough to accommodate the ejection pins 801, alongside with the support wire 406 passing straight between the ejection pins.

Figure 11 also shows that the method of the invention does not require the workpieces to be flexible at any point. This is a basic difference compared for instance with the techniques disclosed by US patent specification 5,478,051, because this specification emphasises that a "guiding element" made of the same material as the service member must be flexible. Many plastic materials (especially those of which protective display windows are made) are so stiff that no part of the workpiece can be made flexible.

Figures 4-9 show that the flowing channel located between the primary pouring channel and the secondary pouring channel is relatively large in cross-section, with its ends extending beyond the secondary pouring channel. This feature is not restrictive for the invention, yet it yields certain advantages. The primary purpose of the flowing channel is, jointly with the secondary pouring channel, to shape the flow of molten raw material before the service member part such that the material flows into the service member part as a front which is as laminar and rectilinear as possible. To eliminate whirls, the ends of the flowing channel preferably extend beyond the secondary pouring channel. Secondly, it should be noted that, as the injection moulding starts, the initial flow consists of material that remained at the end of the "hot channel" extending the primary pouring channel as the previous injection- moulding process ended. This material portion may be oxydated, or may have otherwise disadvantageous properties compared with the remainder of the material. Having a relatively large cross-section and ends extending beyond the

secondary pouring channel, the flowing channel has the effect of pressing the undesired material portion into the ends of the flowing channel (and to the ejection pins perhaps provided here), preventing it from reaching the service member.

The design of the secondary pouring channel also makes it possible to control the regularity of the material flow to the service member. Figure 12 shows a service member of figure 4 and the broken line 1201; figure 13 shows a preferred cross-section of a secondary pouring channel 503 at the broken line 1201. In this case, the ends of the secondary pouring channel are wider than its central part. The material flow distance from the primary pouring channel through the flowing channel and the secondary pouring channel to this service member has the shortest length at the centre of the secondary pouring channel, and the longest length at the ends of the pouring channel. The design of figure 13 reduces the impact of the difference of distance on the laminarity of the material flow in the service member.

The present invention is also well suited for multi-step injection moulding, i.e. for a manufacturing process in which a given workpiece is formed as a result of two or more distinct injection-moulding steps. Below follows a description of the application of the invention to an exemplifying two-step injection-moulding process, in which two-coloured protective windows are manufactured for mobile phone displays.

Figure 14 shows two consecutive workpieces in a band of successive workpieces, where two support wires 1401 and 1402 are used between the workpieces. The direction of movement of the band is from the top towards the bottom in the figure. The upper workpiece has passed through the first injection-moulding step and the lower workpiece has additionally passed through a second injection-moulding step. In the upper workpiece, the diagonal lines indicate the material which is injection moulded in the first injection-moulding step, and in the lower workpiece the diagonal lines indicate the material which is injection moulded in the second injection-moulding step.

The upper workpiece has two annular service members 1403 and 1404, into which material has been supplied through a pouring channel 1405 located in the centre of the area defined by the support wires. The mould used in the first injection-moulding step comprises air pockets at the locations where the support wires 1401 and 1402 pass through the mould, so that conveyor tongues 1406 are formed at the air pockets. The "background" of the mould, i.e. the part through which no material is supplied, also comprises recesses, which will produce ejection pins 1407 and

1408 in the workpiece. The former ones are at the support wires 1401 and 1402 in the conveyor tongues 1406 and the latter ones are located in the bridge 1409 connecting the service members.

In the lower workpiece, an integral central part 1413 and 1414 has been injection moulded within each annular service member formed in the first step. The material has been brought into the central parts through the primary channel 1415 located in the centre of the area defined by the support wires, the secondary pouring channels 1416 and 1417, and the flowing channels 1418 and 1419 between these. At a given location of the edge of the annular service members, free space has been reserved for the secondary pouring channels in the first injection-moulding step. Accordingly, in the first injection-moulding step, air pockets have been left at certain locations at the edge of the annular service members, in which tongues 1420 will arise in the second injection-moulding step. The purpose of using air pockets is to achieve optimal optical quality in the central part. The material used in the first injection-moulding step is typically non-transparent, and free space for the secondary pouring channels 1416 and 1417 and the air pockets 1420 is left behind it, so that the material solidified in the secondary pouring channels and the air pockets in the second injection-moulding step will be invisible. Figure 15 shows the workpieces in cross-section in the plane indicated by the broken line 1421.

Injection moulding is known as a manufacturing process allowing bodies to be manufactured with very high dimensional precision. One consequence of this is that the ejection pins 1407 and 1408 produced in the first injection-moulding step are perfectly suited for positioning the workpiece exactly at the desired location for the second injection-moulding step. On the other hand, the support wires passing between the workpieces ensure that the workpieces can be quite readily transferred from one injection-moulding step to the following step. The embodiment shown in figure 14 even allows complex nested moulds, rotational moulds or moulds reciprocating linearly between the process steps to be totally avoided, these moulds having been required in conventional multi-step injection moulding. The method allows for the use of one single mould with two cavities, in which the upper cavity has been designed for the manufacture of annular service members in the first injection-moulding step and the lower cavity has been designed for the manufacture of the central parts in the second injection-moulding step. Two separate moulds placed in succession in the process can naturally also be used.

The process of figure 14 can very easily be converted into single-step injection moulding by using a mould with two cavities (or two successive moulds with one

single cavity) having identical cavities, and by moving the band of successive workpieces forwards by two workpieces after each injection-moulding operation. In terms of manufacturing techniques, it is very advantageous to be able to use the same injection-moulding apparatus for the manufacture of different products by simply replacing the mould/moulds.

The invention has been described above only in conjunction with a manufacturing process based on injection moulding. Injection moulding has the special advantage of being a method commonly used for the manufacture of relatively small-sized plastic parts with high dimensional precision, and of very exact control of the material flow before solidification, so that the invention is easy to implement. However, the invention is also applicable in connection with manufacturing processes based on moulding or chemical or physico-chemical solidification.

Claims

1. A process for treating workpieces in a manufacturing process, comprising
- forming separate workpieces by solidification of liquid or viscous material in a mould (302)
- forming a band of successive workpieces
- interposing a reinforcement (301) of a material other than the material to be solidified between the successive workpieces in order to enhance the mechanical strength of the band,

characterised in
- interposing between successive workpieces a reinforcement (405, 406, 1401, 1402) comprising two parallel elongated means with the parallel elongated means passing through the mould (302)
- introducing the liquid or viscous material to be solidified into the mould over a given point (501, 1405, 1415) located between said parallel elongated means
- forming between each workpiece and said parallel elongated means an attachment (403, 606, 702, 1406) between the parts of the mould through which said parallel elongated means pass.

2. A process as defined in claim 1, **characterised** in forming workpieces, each of which comprises at least two service members (401, 402, 601, 602, 603, 604, 701, 1403, 1404, 1413, 1414), each service member being formed in the mould between the point over which the liquid or viscous material to be solidified is introduced into the mould and one of said two parallel elongated means.

3. A process as defined in claim 2, **characterised** in that the parallel elongated means are placed so as to pass through the mould at the locations of air pockets (403, 606, 702, 1406) in order to provide exhaust outlets for gaseous substances and to form tongues of liquid or viscous material to be solidified which are not integrated with the service member.

4. A process as defined in claim 1, **characterised** in forming ejection pins (801, 1407) for temporary attachment and detachment of a workpiece to and from a given mould part at specific locations of the workpiece which form an attachment between each workpiece and said parallel elongated means.

5. A process as defined in claim 4, **characterised** in aligning the workpiece with at least one ejection pin (801, 1407) in position for a given subsequent process step after the workpiece has been demoulded.

6. A process as defined in claim 5, **characterised** in aligning the workpiece with at least one ejection pin (1407) in position for a given subsequent process step in which at least one supplementary part (1413, 1414) is formed in the workpiece by solidifying additional liquid and/or viscous material in the mould.

7. A process as defined in claim 4, **characterised** in that, after the workpiece has been demoulded, the workpiece is moved along a given path, the positioning of the workpiece on the path being determined in at least one direction by at least one ejection pin (801).

8. An apparatus for treating workpieces in a manufacturing process, comprising
- a mould (302) for forming separate workpieces by solidification of a liquid or viscous material
- means for interposing a reinforcement (301) made of a material other than the material to be solidified between successive workpieces so as to form a band of successive workpieces,

characterised in that the apparatus comprises
- means for placing two parallel elongated means (405, 406, 1401, 1402) to pass through the mould
- means for introducing the liquid or viscous material to be solidified into the mould over a given point (501, 1405, 1415) located between said parallel elongated means
- means for forming an attachment (403, 606, 702, 1406) between each workpiece and said parallel elongated means in the parts of said mould through which said parallel elongated means pass.

9. An apparatus as defined in claim 8, **characterised** in that it comprises in the mould
- a set of pouring channels (404, 605) for introducing liquid or viscous material to be solidified into the mould over a given point between said parallel elongated means
- air pockets (403, 606, 702, 1406) in the parts of the moulds through which said parallel elongated means pass in order to form an attachment between each workpiece and said parallel elongated means
- at least two service member parts (401, 402, 601, 602, 603, 604, 701, 1403, 1404, 1413, 1414) with each service member part positioned between the set of pouring channels and given air pockets.

10. An apparatus as defined in claim 9, **characterised** in that the set of pouring channels comprises a primary pouring channel (501, 1415) and for each service

member part a secondary pouring channel (503, 608, 1416, 1417) connected with the related service member part and a flowing channel (503, 607, 1418, 1419) between the secondary and the primary pouring channel.

11. An apparatus as defined in claim 10, **characterised** in that each flowing channel (503, 607, 1418, 1419) extends in certain directions away from the primary pouring channel beyond the related secondary pouring channel.

12. An apparatus as defined in claim 10, **characterised** in that each secondary pouring channel (503) is larger in cross-section in given parts remote from the primary pouring channel than in a given part close to the primary pouring channel.

13. An apparatus as defined in claim 8, **characterised** in comprising recesses in the mould for forming ejection pins (801, 1407, 1408) in the workpiece.

14. An apparatus as defined in claim 13, **characterised** in comprising at least one recess in the mould for forming an ejection pin (801, 1407) at the point of the workpiece where the workpiece is attached to one of said said parallel elongated means.

15. An apparatus as defined in claim 13, **characterised** in comprising, in the part subsequent to the mould in the direction of movement of the workpieces, a support and/or actuating member (1001) and means (1002) in this for aligning the workpiece with at least one ejection pin (801).

16. An apparatus as defined in claim 13, **characterised** in comprising a second mould for forming at least one supplementary part (1413, 1414) in the workpiece by solidification of additional liquid and/or viscous material in the second mould, and means for aligning the workpiece with at least one ejection pin (1407) in the second mould.

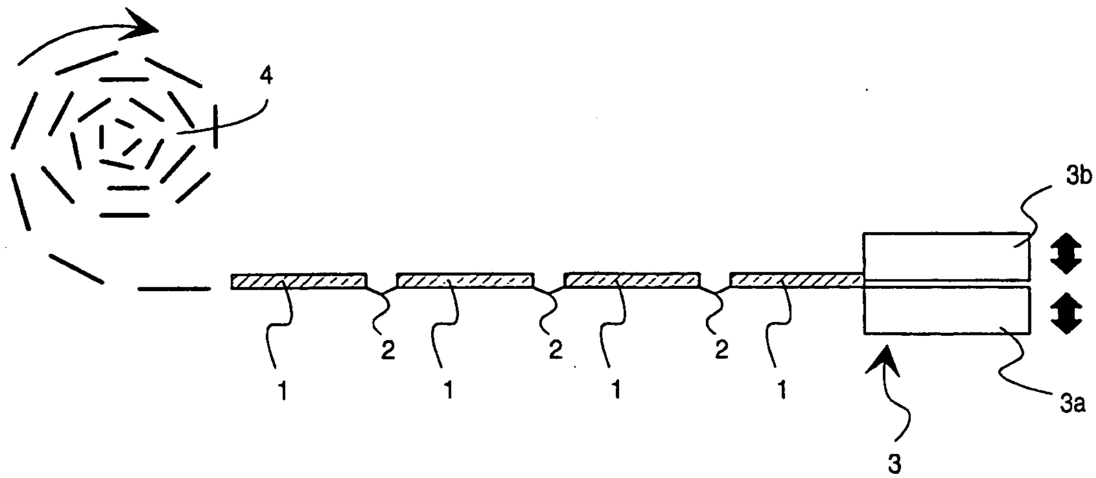

Fig. 1
PRIOR ART

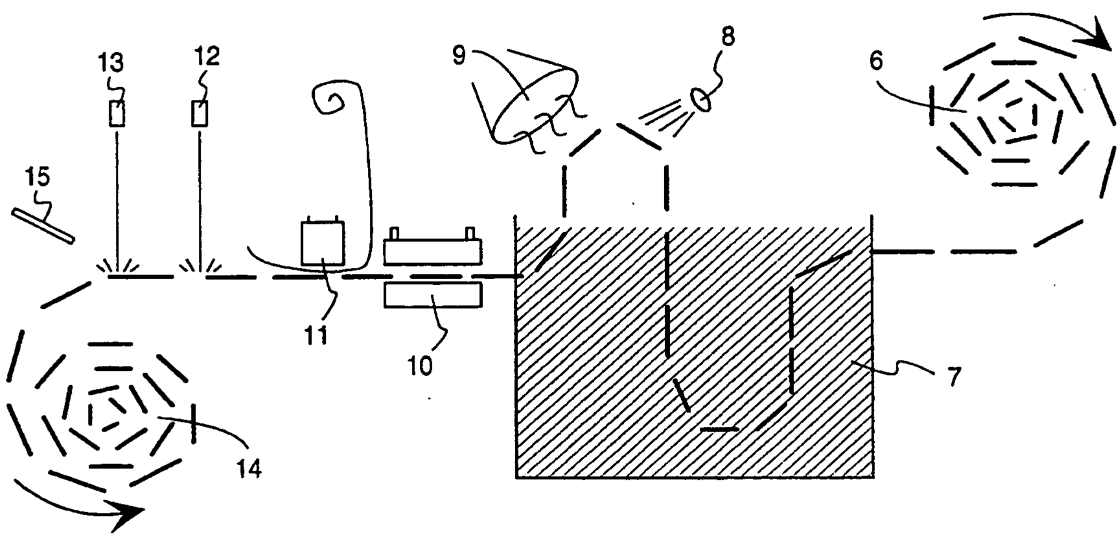

Fig. 2
PRIOR ART

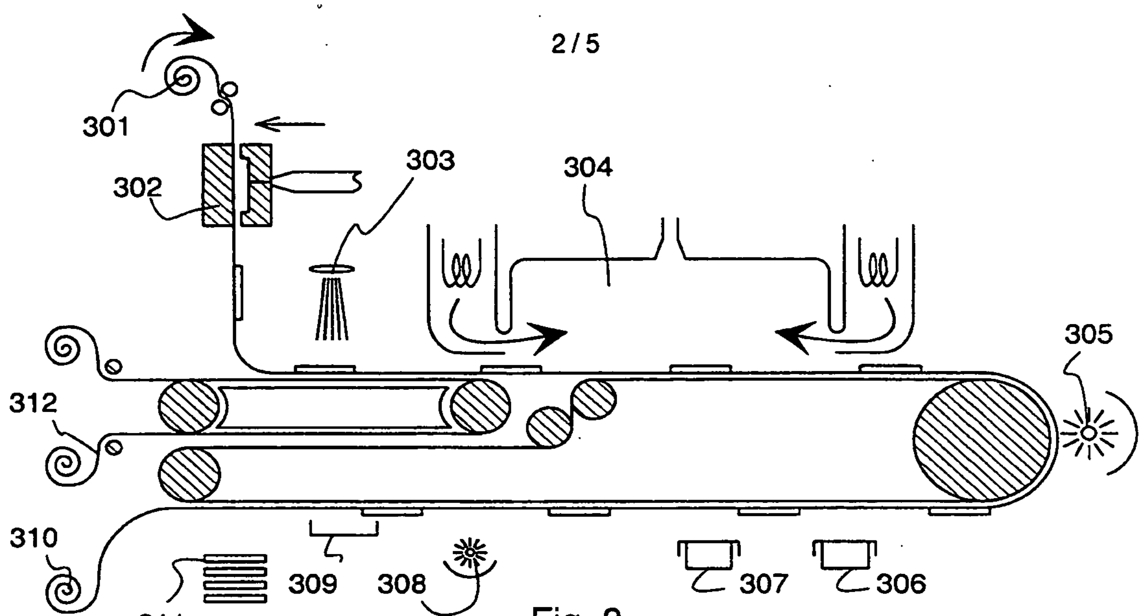

Fig. 3

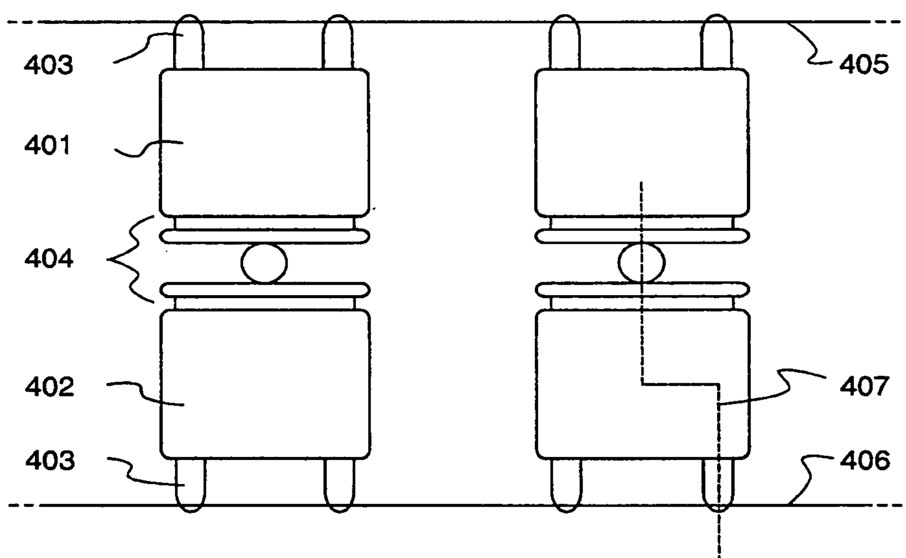

Fig. 4

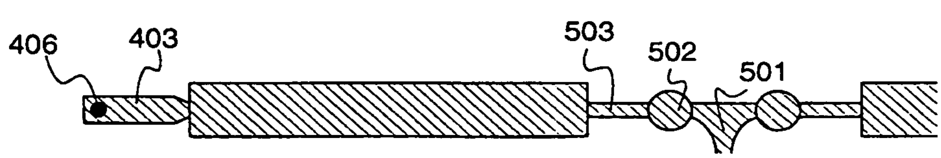

Fig. 5

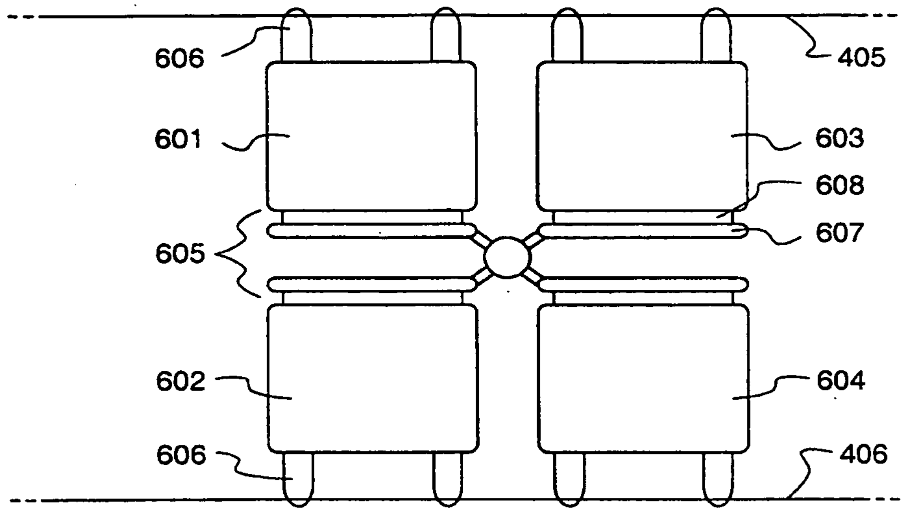

Fig. 6

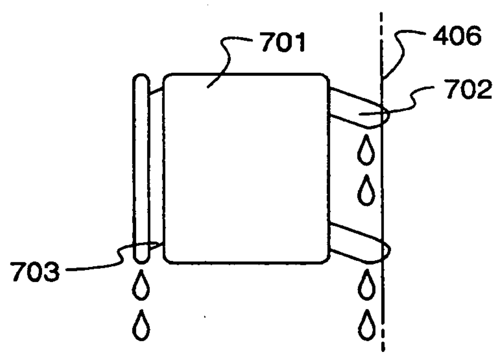

Fig. 7

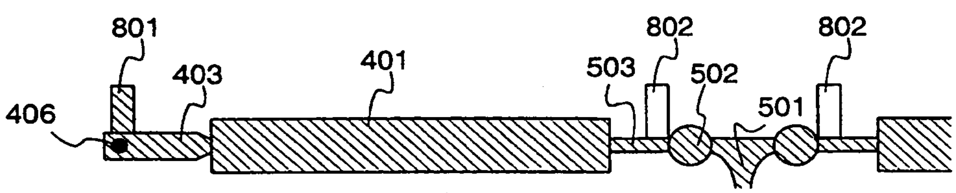

Fig. 8

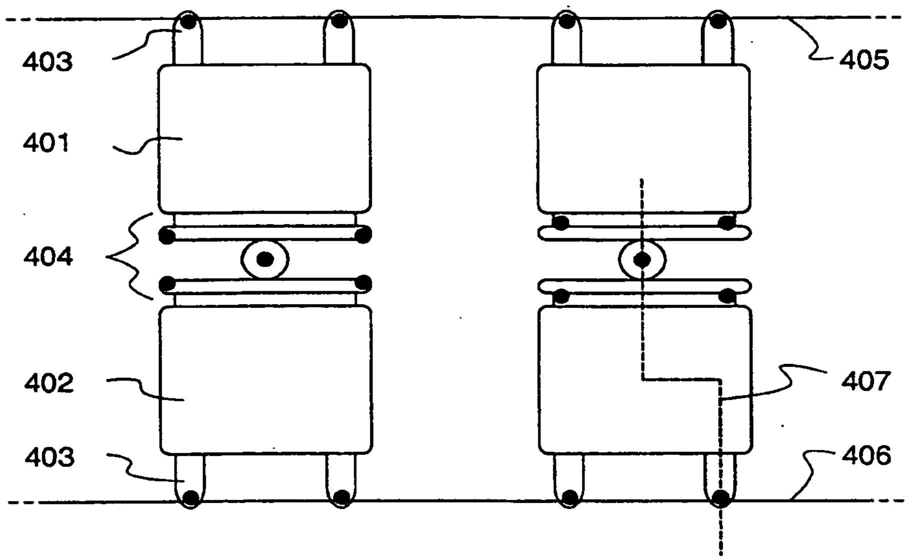

Fig. 9

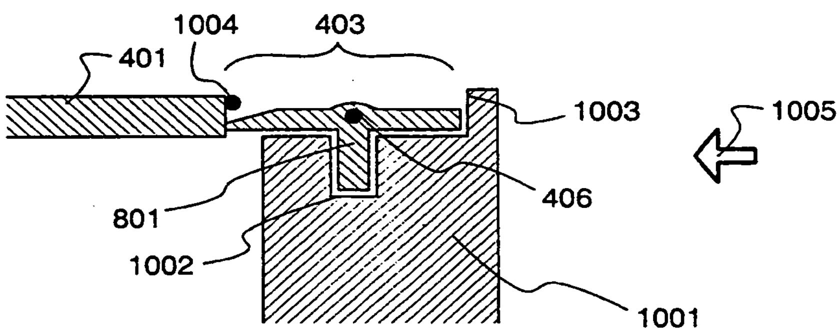

Fig. 10

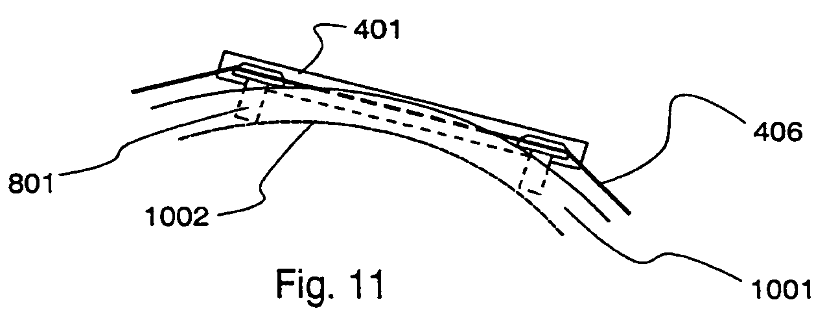

Fig. 11

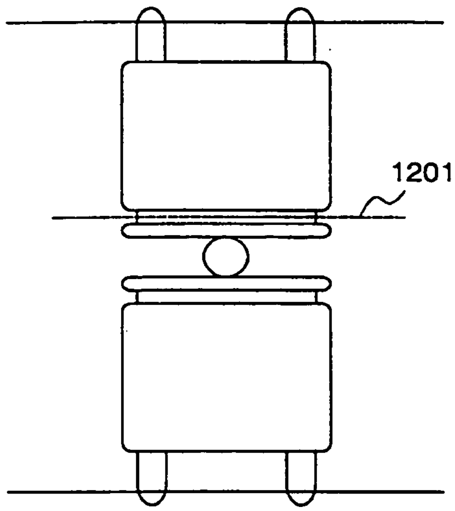

Fig. 12

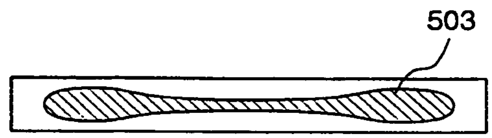

Fig. 13

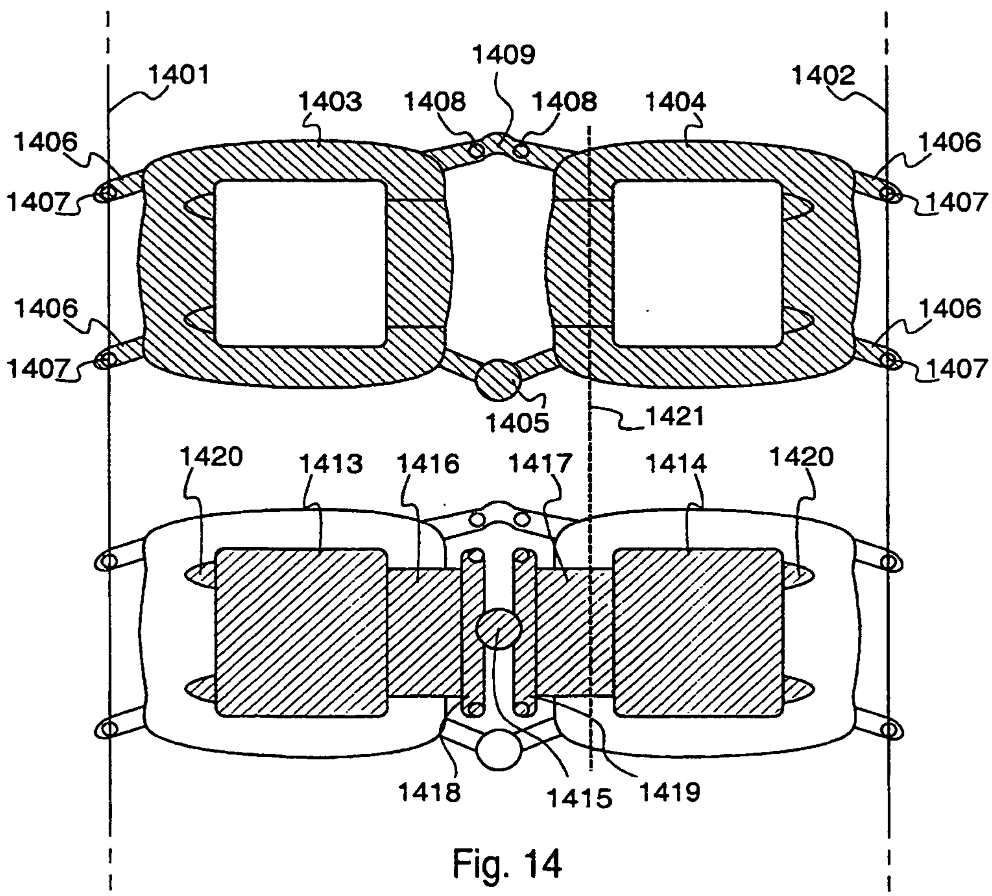

Fig. 14

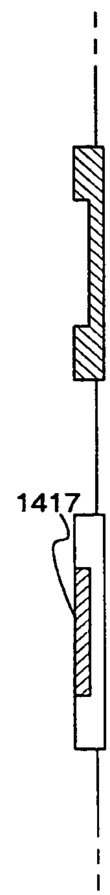

Fig. 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00147

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B29C 45/14 // B29C 045/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B29C, H01R, B65D, B23D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, PAJ, RAPRA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4806405 A (RUDOLF LIEBL), 21 February 1989 (21.02.89), column 3, line 43 - line 57; column 4, line 42 - line 48, figure 1, claim 1, abstract --	1,8
X	US 4362487 A (KIHEI TAKAHASHI), 7 December 1982 (07.12.82), column 2, line 5 - line 44, figure 10, claim 1, abstract --	1,2,4-6,8, 13-15
X	WO 9813186 A1 (RUUTTU, JARI ET AL), 2 April 1998 (02.04.98), figures 1-5, claims 1-6, abstract --	1,8

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 May 2000	15 -06- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Mattias Arvidsson/MP Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00147

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 5478051 A (DIETER MAUER), 26 December 1995 (26.12.95), figures 2-6, claim 1 --	1,8
A	EP 0770806 A1 (EMHART INC.), 2 May 1997 (02.05.97), column 1, line 3 - column 2, line 4, figure 1, claims 1-18, abstract --	1-16
A	US 4249872 A (SEISHIRO AKAURA ET AL), 10 February 1981 (10.02.81), column 1, line 10 - line 63, figures 9,18, abstract -- --------	1-16

INTERNATIONAL SEARCH REPORT
Information on patent family members

02/12/99

International application No.
PCT/FI 00/00147

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